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SHIPS MAINTENANCE, REPAIR AND MODERNIZATION OVERSEAS: REQUIREMENT CONCEPTS AND FUNDING ISSUES IN MAINTAINING MATERIAL READINESS OF DEPLOYED FORCES

by

Keith Lynn Marchbanks

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Thesis Advisor:	Lawrence R. Jones
Associate Advisor:	Jeffrey M. Nevels

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Ships Maintenance, Repair and Modernization Overseas: Requirement Concepts and Funding Issues in Maintaining Material Readiness of Deployed Forces

by

Keith L. Marchbanks
Lieutenant, United States Navy
B.S., Lake Superior State College

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Author: ______________________
Keith L. Marchbanks

Approved by: ______________________
Lawrence R. Jones, Thesis Advisor

____
Jeffrey M. Nevels, Associate Advisor

____
David R. Whipple, Chairman
Department of Administrative Sciences

ABSTRACT

This thesis identifies material readiness issues and the effects of funding constraints on surface ship maintenance and repair requirements overseas. A background discussion of innovative surface ship maintenance and repair concepts is provided. The identification of material readiness and funding issues is accomplished through an examination of overseas surface ship maintenance resource requirements, focusing on the regional areas of Western Asia and the Mediterranean Sea. An assessment of alternative source maintenance costs, underlying issues confronting overseas maintenance and repair contracting, and the effects of current and projected funding trends are presented. The resulting research provides supportive evidence that mobile repair ship capability has, and will continue to be, a critical prerequisite to sustain material readiness of deployed forces in remote geographical locations during periods of regional crisis.

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I. INTRODUCTION

A. GENERAL

One of the major challenges facing the American military in the 1990's is how to maintain a quality force under austere conditions with reductions in defense spending. The following passage from Weidenbaum's *Small Wars, Big Defense*, describes this challenge:

> The military establishment of the United States resembles a heavily loaded, rapidly moving vehicle. The driver is trying to reduce the speed substantially, but without shaking up the passengers too badly and while keeping the car on the right side of the road. As the driver slows down, there are all sorts of noises in the engine. This reminds the driver that the vehicle is overdue for repairs and maintenance. [Ref. 1]

The end of the cold war has dramatically altered the strategic balance of power between the United States, the former Soviet Union, and other nations of the world. Recent and significant events, such as the reunification of Germany and formulation of the European Economic Community (EEC), have also contributed to a tidal wave of change that is now engulfing the world. A new military strategy is emerging within the United States to reflect these changes. This strategy is geared toward implementation by a smaller force. At the same time, it demands that naval forces capability remain high.

Maintaining a quality naval force under a reduced defense budget will ultimately result in fewer ships and personnel in the fleet. Training, maintenance support, and operating procedures must be transformed to meet this challenge. In a recent article in *Naval Institute Proceedings*, "Doing the Job with a Smaller Fleet," Admiral Paul Miller, Commander-in-Chief, U.S. Atlantic Fleet, addressed the issue of diminishing resources as follows:

> This creates a catalyst for change, bringing with it the risks of innovation. No sweeping solutions exist, but there are ways to whittle the problems down to size. [Ref. 2]

New strategic initiatives are now being formulated in the Navy in a concerted effort to maintain a quality force, despite budget constraints, to keep pace with the changing threat environment. These initiatives include standardizing selected procedures between the Atlantic and Pacific fleets, alternative naval force packages to satisfy requirements of unified commanders, organizational restructuring and streamlining, and creation of multimission capabilities for optimal use of current assets. [Ref. 2]

This thesis focuses on the ship maintenance and repair component of the overall challenge to the Navy to operate more efficiently in the future. In the ship maintenance and repair area, the phased maintenance concept, progressive maintenance concept, and an engineered operating cycle are three new ship

maintenance strategies now being implemented in an effort to improve efficiency. These concepts may ultimately be managed under a single fleet-maintenance command (Afloat Maintenance Command) [Ref. 2].

At issue is while operating under the umbrella of fiscal constraint, these changes may also effect the availability of adequate shore facilities and the continued use of mobile maintenance platforms overseas. Maintenance capabilities provided by shore activities and their relative proximity to an assigned area of operation are factors which could affect decision-makers in managing risk. The use of mobile maintenance platforms as back-up could also heavily influence maintenance and repair decisions, particularly when applying the concept of conditional based maintenance. Political ramifications stemming from a "wrong" decision and reluctance to change the current system further complicate the practice of performing maintenance based on actual material conditions.

B. OBJECTIVES

The primary objective of this thesis is to assess innovative material readiness issues and the effects of funding constraints on surface ship maintenance and repair requirements overseas. A secondary objective of this research effort is to examine some of the critical issues confronting the Ship Maintenance and Repair Division of Naval Sea Systems Command (NAVSEA) and, in particular, the concept of condition

based maintenance. Finally, it is envisioned that this assessment will provide additional insight to assist fleet maintenance decision-makers in validating and justifying the use of scarce resources.

C. RESEARCH QUESTIONS

In pursuit of these objectives, research is based on the following four questions:

1. What are the critical requirements and funding issues confronting maintenance resource facilities overseas?
2. What effect will new Navy maintenance strategies have on planned requirements assigned to maintenance facilities overseas?
3. Can Maintenance Requirement System (MRS) principles be applied during periods of deployment to improve material combat readiness?
4. How can the concept of conditional based maintenance be reinforced through the use of mobile maintenance platforms such as tender repair ships?

D. RESEARCH METHODOLOGY

Research data were collected by means of an extensive literature search, and telephone and personal interviews. Literary sources examined included published and unpublished papers, periodicals, general reference texts, and existing government publications. A complete list of literary sources used is contained in the List of References.

Research was conducted in 4 major steps:

1. Interviews with Naval Sea Systems Command Detachment, PERA (SURFACE); Naval Sea Systems Command (NAVSEA) (SEA-915/935); Naval Ship Systems Engineering Station (NAVSSES) (101); Appropriation Matters Office (OP362); Commander Service Force Sixth Fleet (COMSERVFORSIXFLT) (60); and Naval Regional Contracting Center, Naples, Italy.

2. Examination of overseas maintenance facility organizations, strategy, capabilities, accomplishments, and current trends in maintenance requirements by perusal of official documents, supplemented by interviews.

3. Assessment of funding constraints on overseas shore based maintenance facilities and justification for the continued use of mobile maintenance platforms (tenders).

4. Evaluation of MRS principles and the potential for applying the concept of condition based maintenance to afloat units during deployment.

The resulting research provides a consolidated insight on actual requirement trends and related funding issues including deployed units in an overseas environment.

E. SCOPE OF STUDY

This study provides an overview of surface ship maintenance and repair requirements for deployed units. Funding constraints are identified and assessed, including the continued use of mobile maintenance platforms and performance of unscheduled repairs. Justification for deployed repair assets and flexibility in overseas maintenance and repair contracting is also addressed.

The overview of requirements and funding aspects center on the Sixth Fleet with a limited analysis of noted similarities that may be applicable to the Pacific Fleet.

Finally, the principles supporting the Maintenance Requirements System are addressed to include an assessment of risk management criteria.

F. ORGANIZATION OF STUDY

This thesis consists of five chapters. Chapter I has outlined the objectives of the study in addition to providing comment on both the scope of the study and research methodology used.

Chapter II provides the background on innovative surface ship maintenance and repair issues. Discussed are surface ship maintenance strategies, ships employment cycle, and innovative support tools to enhance decision-making based on the concept of condition based maintenance.

Chapter III provides an overview of ships maintenance and repair requirements overseas. Critical material requirements and funding issues confronting both shore and mobile maintenance platforms are identified.

Chapter IV provides an analysis of data collected from research on critical issues concerning overseas resource requirements.

Chapter V summarizes the results of the research, presents conclusions, and provides recommendations for potential areas of further research.

An appendix and a List of References are provided for information and to facilitate further research in this area.

II. BACKGROUND ON INNOVATIVE SURFACE SHIP MAINTENANCE AND REPAIR ISSUES

A. INTRODUCTION

Maintaining Navy ships' combat and engineering systems fully capable and up-to-date results in placing ships off line for periods of overhaul, repair, and modernization. With the pace of technological development continuing to accelerate, the time required for major ship maintenance must now be reduced while increasing the percentage of the fleet available for employment. [Ref. 2]

This chapter will address new strategic surface ship maintenance and repair initiatives that are now being implemented in a concerted effort to maintain a quality force, despite impending budget constraints.

B. SHIP MAINTENANCE AND REPAIR STRATEGIES

Three innovative ship maintenance strategies have now been implemented in an effort to enhance maximum operational availability at the lowest practical cost and are based in part on OPNAVINST 4700.7H which states:

> Class maintenance plans will be developed for each ship class following the concepts of Reliability-Centered Maintenance. A thorough knowledge and assessment of actual equipment condition in relation to its designed condition is the basis for maintenance decisions. Based on knowledge of the material condition of the ship and equipment, the Fleet Commander for his designated

subordinates shall determine the maintenance actions required...using Reliability-Centered Maintenance principles to the maximum extent possible. [Ref. 3]

Ship class maintenance strategies are described in the following subsections. [Ref. 3]

1. Phased Maintenance Concept

The phased maintenance program (PMP) applies to most ships. With some exceptions, regular overhauls are eliminated. The requirement for maintenance repair and modernization is accomplished through a series of shorter phased maintenance availabilities (PMAs) scheduled throughout the employment cycle of each individual ship. The goals of PMP are to maximize ship availability, improve operational readiness, and upgrade material conditions.

Both repairs and modernization are included in the PMAs. Ships are scheduled at 15 to 18 month intervals to undergo PMAs, each averaging approximately three months in duration. An assigned port engineer remains with the same ship throughout its operating cycle, and is involved in the planning, budgeting, authorizing, and execution of all maintenance actions. Adherence to the principle of reliability-centered maintenance is mandatory.

The phased maintenance concept emphasizes program uniformity among the various ship classes and encompasses the following criteria:

1. Base repair decisions on actual condition assessment information.

2. Use qualified port engineers in the repair definition process.

3. Ensure production contractor participation in the advance planning process.

4. Have availabilities executed in ship homeports.

5. Provide flexibility to add or delete work during availabilities.

6. Preserve repair decision approval authority in ship's commanding officers, Type Commander port engineers, and Supervisors of Shipbuilding, Conversion and Repair.

2. Progressive Maintenance Concept

The progressive maintenance concept (PROG) applies only to a small number of ships. The Chief of Naval Operations (CNO), in directing the acquisition of the FFG 7 (Guided Missile Frigate) and the PHM 1 (Patrol Combatant Hydrofoil, Missile) classes of ship, imposed constraints in the areas of cost (design-to-cost), displacement, and shipboard manning. These constraints resulted in development of the PROG strategy to compensate for reduced manpower by minimizing organization level maintenance requirements while also maintaining maximum operational availability.

The class employment cycle is based on a ten year interval between major modernization and conversion overhauls. Between these periods, maintenance is to be accomplished by performing a discrete set of maintenance actions during

scheduled intermediate maintenance availabilities (IMAVs) and selected restricted availabilities (SRAs) to optimize on-line availability for the ships. Some ships homeported in forward deployed areas have operational tempos that are most effectively supported by the PROG concept and are to undergo short availabilities by a ship repair facility (SRF).

Maintenance support for these ships is dependent upon a change-out maintenance capability and capacity, and cycle schedule discipline. The key to this concept is the ability to conduct engineering analysis of installed equipment and systems to determine their failure rates, related effects and the extent of support required. The analysis provides the basic core data in formulating the preventive maintenance plan, estimating corrective maintenance requirements, and establishing the level of repair (organizational, intermediate or depot).

3. Engineered Operating Cycle Program

The engineered operating cycle (EOC) establishes a structured and engineered approach for maintaining aircraft carriers, large amphibious ships, nuclear submarines, and other complex classes. EOC programs define and implement a specific maintenance class strategy with the primary goal of sustaining combat readiness while increasing peacetime operational availability at an acceptable cost.

Because of complexity, these ships require closer management of regular overhauls and combine required maintenance with planned modernization at specific points in each ship's life cycle.

Engineering analysis is the basis for defining and scheduling maintenance to be performed during periods of assigned availabilities. In a planned operating cycle, an assessment of equipment (AEC) for specified systems and equipment is performed by a performance monitoring team (PMT). The AEC is normally accomplished [illegible]-90 days before the start of an SRA and again upon completion of the SRA to measure designated system and equipment condition parameters. Repair recommendations are then made based on *actual* conditions encountered during each visit or subsequent technical analysis for revision of the ship's class maintenance plan (CMP). The CMP serves as the planning tool which prescribes the fundamental life-cycle set of applicable intermediate and depot level maintenance tasks needed to sustain material readiness.

The EOC program has also expanded planning yard responsibilities to improve design, material planning, and coordination between the operating forces and systems managers. Such is the case of the highly integrated Aegis ships. The planning yard must now merge maintenance and modernization planning and advance the application of

condition based vice time-based maintenance for all ship systems. [Ref. 4]

C. EVOLUTIONARY EMPLOYMENT CYCLE

A new employment concept is now envisioned that will merge the various maintenance improvement programs, previously outlined in this chapter, into a standardized employment cycle format. The cycle would consist of three functionally distinct phases identified as refit, ready fleet, and deployment. [Ref. 2]

Although the various maintenance and repair strategies are tailored to a specific ship class, every unit would almost always be operating in one of the three phases. Regular or refueling overhauls would constitute a fourth phase, whenever required.

Refit is the first phase, is approximately eight weeks in duration, and begins after a ship returns from deployment. During this phase, the unit will complete individual and team training requirements as well as other basic training milestones ashore. A refit unit will maintain a specified minimum readiness level and undergo two maintenance availability periods. The first and longest maintenance availability, roughly equivalent to an SRA, will start shortly after the beginning of the refit phase. The second maintenance availability is shorter in duration, similar to an

IMAV, and will be completed just prior to the end of the refit phase.

Approximately six months before deployment and after completion of all training, inspections, and maintenance requirements, the ship will enter the ready fleet phase. As a ready fleet asset, the unit will be under the operational control of a separate fleet commander and will be available for operations and exercises close the continental United States. The unit will also maintain a higher level of readiness and will be available for deployment within four to ten days as part of a possible surge force. One and possibly two phased-maintenance availabilities will be scheduled during this period with the intent of enhancing the full level of material readiness required for the impending deployment.

Deployment represents the final phase of the employment cycle, averaging approximately six months in duration. This phase begins on the day of departure from the unit's homeport and ends on the day of return. At least one additional maintenance availability will be performed during this period to ensure that required material readiness is sustained.

Unless a ship has been scheduled for a regular or refueling overhaul, the unit will again enter the refit phase upon completion of deployment. Therefore, according to this researcher, the employment cycle as currently envisioned resembles that of a *revolving* employment cycle.

D. INNOVATIVE TOOLS FOR MAINTENANCE MANAGEMENT

Class maintenance plans (CMPs) are the heart of the Navy's ship maintenance strategy. To translate these plans into maintenance actions requires procedures for the assessment of equipment condition, determination of material requirements, and evaluation of actions taken.

As previously noted in Section B of this chapter, the CNO has directed that CMPs be based on the concept of reliability-centered maintenance. This requires a thorough knowledge and assessment of actual equipment condition in relation to its designed condition.

Equipment condition is a broad term that includes static parameters such as size and shape, and dynamic parameters such as speed, temperature, and pressure. Although ship's force is in the best position to know the condition of the ship and equipment, specialized assistance is often required to determine the actual condition of much of the equipment [Ref. 3]

1. Assessment of Equipment Condition

In December 1988, the Assessment of Equipment Condition (AEC) Office was established at Naval Ship Systems Engineering Station (NAVSSES) to realign systems monitored to reflect type and fleet commander priorities and to implement the condition based maintenance strategy for all surface ship classes. The primary thrust of this approach is to provide

shipboard personnel with the necessary diagnostic tools and techniques that would enhance condition based decision-making. Ultimately, this could also permit the most cost effective management of risk in Navy maintenance. Without condition based information, maintenance decisions would continue to be made on either timed or arbitrary insurance basis. [Ref. 5]

The AEC Program integrates condition based maintenance into the work definition process with the use of performance monitoring teams (PMTs) to conduct pre- and post depot level availability ship visits to determine actual equipment condition, and provide repair recommendations to availability planners [Ref. 3].

Numerous initiatives to develop automated procedures and diagnostics for condition based maintenance are also now in progress. Computer based expert system prototypes, designed to monitor and assess machinery condition through on line sensors, are being installed on designated units representing all major surface ship classes. Those prototypes will monitor 30 ships systems identified as the most cost burdensome to type commanders. The NAVSSES Condition Based Maintenance Branch is supporting the evaluation of those prototypes. [Ref. 5]

The evolution to reliability-centered maintenance (condition based) appears to be underway. The end product, as envisioned by NAVSSES, is a maintenance contingent

encompassing ships force, fleet level support activities (PMTs and RSGs), and the in-service engineering agents and life-cycle managers. Ship's force preventive maintenance system (PMS) workload is intended to be greatly reduced, and major repairs and overhauls will be based on actual equipment condition. [Ref. 5]

2. Measures of Effectiveness

A declining defense budget is a major factor which will influence the way the United States Navy does business in the future. The recent developments in surface ship maintenance strategies, discussed in the previous sections of this chapter, were implemented on the premise of achieving reduced maintenance costs and improving the availability of shipboard systems. Programs such as AEC will not be accomplished without the expenditure of scarce resources. Accurate measures of effectiveness (MOE) will be needed to enhance cost effectiveness and justify expenditure of funds [Ref. 6].

Ship maintenance is performed at the depot, intermediate, and organizational levels. Depot level maintenance refers to all maintenance activities performed in public and private shipyards. The work is performed by civilian employees. Intermediate maintenance is performed by Navy enlisted personnel at a shore intermediate maintenance activity (SIMA) or a tender (mobile maintenance platform).

Organizational level maintenance is that work performed by the ship's force. To obtain an adequate representation of maintenance costs, all three levels of maintenance must be accessed and tracked at the fleet, class, ship, and equipment levels. [Ref. 3 and 6]

In the recent article in *Naval Engineers Journal*, "Measures of Effectiveness as Applied to Maintenance Periods," Elfont and Procaccino contend that data sources to support MOE are already in place via other programs. Depot level cost data can be obtained by access to the Planning and Engineering for Repairs and Alterations (PERA) corporate data base. This database contains cost data from completed and authorized Ship Alteration and Repair Packages (SARPs). The data are stored and accessible by fleet, class, hull, Ship Work Authorization Boundary (SWAB), and Ship Work Line Item Number (SWLIN) for various types of depot level availabilities. NAVSSES presently houses and maintains a database which contains depot level cost data for Hull, Mechanical, and Electrical (HM&E) systems. These data can be used in conjunction with intermediate and organizational level cost data extracted from the Maintenance Data System (3M system), via the NAVSSES Ships Machinery Analysis and Research Technique (SMART) system. Data from this source already have been used in the system selection process for the AEC Program. [Ref. 6]

The above data will be used to establish cost trends for each ship class and hull. These trend analyses will show which systems have been most positively affected by AEC monitoring and will identify the systems that are not performing as planned. In addition, these data will be used to trend and compare the 30 selected AEC systems for a given class or hull versus other systems not covered by the AEC Program. [Ref. 6]

The Visibility and Management of Operating and Support Costs (VAMOSC) database is another information source that will be used to monitor the extent of effectiveness of the AEC Program on a higher level. This database tracks operating and support (O&S) costs at the ship level for all active fleet ships. These data will be used for cost trend comparison of a group of individual systems versus total direct depot or intermediate maintenance costs. [Ref. 6]

Cost is not the only factor which should be considered when assessing the effectiveness of a particular maintenance practice. The perceived benefit of condition based maintenance is a reduction in cost, but availability or operational readiness cannot be sacrificed for the sake of cost. Operational availability is the availability of a system to perform its function at any point in time that it is required to do so. This represents the actual availability of the system and considers all equipment down time, including

repair time logistical delays. The required data to assess this availability can be extracted from the Maintenance Data System (MDS) and casualty report (CASREP) systems via the SMART system located at NAVSSES. [Ref. 6]

Finally, Elfont and Procaccino conclude that MOE has the potential to be an effective and cost efficient method for gaging and improving the effectiveness of condition based maintenance. MOE will provide a valuable tool to maintenance managers at the organizational, intermediate, and depot levels of maintenance, to identify and correct problems associated with their equipment and maintenance strategy. [Ref. 6]

E. MAINTENANCE REQUIREMENTS SYSTEM

1. Purpose

The Surface Ship Maintenance and Repair Division of Naval Sea Systems Command (NAVSEA) has been tasked to develop a process for surface ship maintenance budget preparation and justification that will identify projected funding requirements, and assess the impact of potential funding shortfalls below requested levels [Ref. 7].

This task was supported in part by Department of Defense Directive 5000.39 which states that adequate funding be included in budget requests to meet system readiness objectives and identify the readiness impact of failing to provide requested funding. Department of Defense Directive 5000.39 was replaced by Part 7, Section A of Department of

Defense Instruction 5000.2 on 23 February 1991. Section A establishes Integrated Logistics Support (ILS) acquisition policy to ensure that support considerations are effectively integrated into system design, and that required support structure elements are acquired concurrently with each new system. This will enable a system to be both supportable and supported (funded) when fielded.

Furthermore, ILS planning must be focused at the level at which support resources must be integrated to affect maintenance. This is the level at which specific repair or maintenance will occur, and is usually at the subsystem level or below. [Ref. 8]

2. Basic Structure

In response to this task, the Maintenance Requirements System (MRS) concept was developed by NAVSEA based on three separate but interrelated processes [Ref. 9]:

1. Define the requirements. Determine the maintenance required to be performed during an availability to ensure the safe and reliable operation of the ship during its follow-on operating cycle.

2. Project the requirements to support budgeting. Intelligently project those requirements over the POM years to ensure adequate funding is programmed to execute those requirements.

3. Manage risk in a constrained funding environment. If unable to program to the required level, identify the potential impacts of funding to a lower level and articulate the impact on the Navy's ability to carry out its assigned mission.

The first process of defining requirements is the foundation upon which MRS is based. Maintenance requirements are defined by way of the availability planning process. The strength of this process is that it identifies real maintenance requirements for a particular ship during a specific maintenance availability, based on both validated time directed maintenance requirements and the actual condition of the ship as determined during the maintenance planning process.

Completeness, accuracy, and timeliness of feedback is mandatory to facilitate continued improvement of the MRS process. This includes feeding useful information into the various maintenance databases, providing ready access to all participants who need the information, and centralizing the process by interfacing existing databases.

The maintenance and repair requirement definition process provides the information upon which subsequent MRS steps are based. The output from projecting requirements to support budgeting and the management of risk will only be as good as the input provided by the process that defines the requirements.

3. Risk Management Theory

Operating in a constrained funding environment may ultimately result in providing adequate support to less ships or, at the other extreme, providing inadequate support to a

greater number of ships with a deteriorating capability in material and manpower readiness. The ability to meet national security objectives must be supported by balancing force structure and force readiness. A process tool is needed for type commanders, fleet commanders, and OPNAV to manage the risk associated with reduced maintenance funding.

NAVSEA is currently developing this process by defining risk at the maintenance work item level using the following basic formula [Ref. 9]:

RISK = SEVERITY X PROBABILITY

where:

Severity = the significance of an outcome based on safety and system mission importance,

and:

Probability = the likelihood of an outcome where the system will be inoperative if not maintained.

The *relative* risk is the risk associated with each maintenance work item within an availability where the systems will fail during the next operating period if the work item is not performed.

Risk is then analyzed for each work item scheduled for a specific availability. Upon sorting work items in descending order of risk, an assessment can be made using

sensitivity analysis to simulate the impact of various funding constraints and also some possible mission effects.

F. SUMMARY

This chapter has addressed some of the innovative concepts and programs that are now being implemented in response to critical surface ship maintenance and repair issues. These concepts and programs have evolved under the premise of continued fiscal constraint, requiring that the Navy uphold interests of national security with a smaller fleet.

The maintenance and repair strategies of PMP, PROG, and EOC all enhance the concept of condition based maintenance and standardization of class maintenance plans. Innovative tools for maintenance management such as AEC and MOE reinforce the concept of condition based maintenance and examine its effectiveness. The evolving or *revolving* employment cycle will further standardize ship class utilization throughout respective operating cycles.

Finally, the MRS concept provides a valuable tool in planning, budgeting, and assessment to minimize the impact of fiscal constraint, and to improve efficiency in decision making.

The next chapter provides an overview of surface ship maintenance and repair requirements overseas.

III. OVERVIEW OF SURFACE SHIP MAINTENANCE AND REPAIR ACTIVITIES OVERSEAS

A. INTRODUCTION

This chapter provides an overview of overseas surface ship maintenance and repair requirements, focusing on the regional areas of Western Asia and the Mediterranean Sea. There are two reasons for this approach. First, during the period from April 1990 to July 1991, areas within the Arabian Gulf, North Arabian Sea, Red Sea, and Eastern Mediterranean Sea were witness to the largest deployment of United States naval forces since the Second World War. This rapid buildup presented overseas based maintenance managers with a multitude of surface ship maintenance challenges.

Secondly, Operation Desert Shield, Operation Desert Storm, and Operation Provide Comfort all employed naval forces in response to regional conflict. In the January 1992 document, *The National Military Strategy of the United States*, General Colin L. Powell, Chairman of the Joint Chiefs of Staff, addressed the need for regional focus:

> Because of the changes in the strategic environment, the threats we expect to face are regional rather than global. The growing complexity of the international security environment makes it increasingly difficult to predict the circumstances under which US military power might be employed. Hence, forward presence and crisis response are fundamental to our regionally oriented strategy. [Ref. 10]

If the security interests of the United States require a shift from global to regional strategy, the United States Navy must be prepared to support deployed surface ships in remote geographical locations such as the Arabian Gulf and Eastern Mediterranean Sea.

B. MEDITERRANEAN MAINTENANCE STRUCTURE

1. Organizational Responsibilities

Commander, Service Force Sixth Fleet (COMSERVFORSIXTHFLT), a component of the United States Sixth Fleet, is located in Naples, Italy. COMSERVFORSIXTHFLT is responsible for maintenance and repair support for all ships of the United States Sixth Fleet in the Mediterranean Sea, all United States navy ships operating in the eastern Atlantic Ocean off the west coast of Africa and Northern Europe, and all Commander, United States Naval Forces Central Command (COMUSNAVCENT) ships operating in the Red Sea. [Ref. 11]

For purposes of command and control, the Sixth Fleet organization located in Naples, Italy is comprised of the following three functional support components:

1. Commander, Service Force Sixth Fleet provides overall surface ship maintenance and logistics support.
2. Commander, Task Force Six-Three provides underway replenishment and at-sea support requirements.

3. Commander, Naval Force Group Mediterranean provides overall administrative support requirements.

All three organizational components are managed and administered under a single staff. Four organizational elements directly support surface ship maintenance and repair. [Ref. 11]

a. Comptroller Unit

The Comptroller Unit, located at Naples, Italy, is staffed with four civil service employees. The Comptroller Unit is responsible for management and fiscal accountability of the COMSERVFORSIXTHFLT maintenance budget.

The COMSERVFORSIXTHFLT maintenance budget is supported from several *pots of money* such as CINCLANTFLT Technical Operating Budget, CINCPACFLT 2275 Funding Document, CINCLANTFLT Muse open ended allotment, CINCUSNAVEUR Operating Budget, and the COMNAVSURFLANT Operating Target (OPTAR). In addition, all Pacific Fleet Mideast commercial maintenance funding is managed directly by the COMSERVFORSIXTHFLT Comptroller in Naples, Italy.

b. Ship Repair Unit

The Ship Repair Unit (SRU), an industrial maintenance activity located at Naples, Italy, is staffed with two military officers and 18 civil service employees, most of which are ship surveyors. The SRU is responsible for planning

and overseeing all commercial industrial hull, mechanical, and electrical (HM&E) voyage repairs on surface ships.

The bulk of COMSERVFORSIXTHFLT maintenance funds are managed through the SRU. In compliance with Section 7309(c) of Title 10, United States Code, the SRU charter permits accomplishment of voyage repairs though *not* the overhaul of ships based (homeported) in the continental United States (CONUS). Section 7309(c) of this legislation prohibits ships homeported in the United States from being overhauled, repaired, or maintained overseas except for voyage repairs.

c. Mobile Technical Unit Six

Mobile Technical Unit Six (MOTU SIX) is closely associated with SRU and is staffed with one military officer and 35 military and civilian technicians. MOTU SIX technicians provide on-the-job training and responsive (upon request) technical assistance to afloat units for repair, maintenance, and operation of electronics, communications, and weapons systems.

d. SRU Detachment Bahrain

SRU Detachment Bahrain serves as a forward on-site SRU coordinator and is staffed with ships surveyors, HM&E technicians, and combat systems technicians. During Operation Desert Storm, COMSERVFORSIXTHFLT was temporarily augmented by 67 additional personnel, 54 of which were assigned to SRU Detachment Bahrain.

2. Surface Ship Maintenance and Repair Policy

Surface ship maintenance for deployed and overseas homeported ships is provided based on the following priorities: [Ref. 12]

1. Emergent maintenance involving C-3 and C-4 CASREPS.
2. Emergent maintenance involving C-2 CASREPS.
3. Planned maintenance availabilities.
4. Continuous Ship-to-Shop availability.
5. Periodic inspection requirements.

Emergent repairs, conducted in remote locations away from industrial facilities to correct CASREPS, are accomplished by the use of repair Fly-Away-Teams (FATs) or Tiger Teams from either a deployed tender or shore based repair activity. These teams are transported to the affected unit by surface craft or helicopter and provide skills, equipment, and technical expertise necessary to augment ship's force in correcting the casualty.

In addition to local (in theater) teams, Technical Assistance and Tiger Team FATs from CONUS can be used for high interest and major casualty repairs. The use of CONUS teams is far more expensive compared to local teams and is normally viewed by responsible maintenance managers as a final and last resort alternative for this reason.

Continuous *Ship-to-Shop* availability, between the tender repair department and the supported unit, is the maintenance and repair of equipment based on individual and independent repair actions. An individual piece of equipment or gear is removed from the respective ship's system, packaged, and shipped through the Navy transportation system to a nearby Mediterranean tender or shore based repair facility. The equipment is then repaired by the repair activity and returned via the transportation system to the supported unit.

Planned maintenance and repair for deployed units varies depending on length of deployment and type of availability required. Typically, one formal, uninterrupted two-week availability (IMAV) may be scheduled alongside a tender or one two-week restricted availability (RAV) may be scheduled at a shipyard for the first three months of a deployment. Additional periods are scheduled when feasible based on five days of IMAV or RAV time for each additional month of deployment. Fourteen days might also be scheduled for ship's force upkeep during the first three months of deployment, with an allotted five days of upkeep for each additional month of deployment.

Final planning of depot level maintenance periods (RAVs) is generally accomplished based on the following pre-availability time sequence: [Ref. 12]

A-45 days	Ship's work package is submitted to SRU.
A-35 days	Work package is screened by the typedesk.
A-30 days	Work package undergoes surveyor review.
A-21 days	Surveyors conduct ship check.
A-18 days	Surveyors write requirement specifications.
A-07 days	Funding requirements are estimated and justified.
A-00 days	Supported ship arrives. Prospective contractors initiate ship check.
A+01 days	Repair contract is awarded. Contractor orders non government furnished material. RAV commences on jobs ready for work.

Capabilities of the various shipyard and commercial contractors vary throughout the Mediterranean region and generally accomplish only merchant ship type repairs. Repair of optical systems, electronics, and combat systems are scheduled to be done by tenders.

Final planning of IMAVs is relatively simple. A current Mediterranean Work Package (MWP) for the supported unit is held on-board the tender assigned to perform the availability. Approximately 30 days prior to the scheduled IMAV, the supported unit sends the tender a message listing of all work that the ship commanding officer desires to have accomplished. If feasible, a team from the tender will ship check the work package approximately two weeks before the start of the IMAV. Upon identifying the actual jobs to be

worked, final preparations are made in an effort to start as many work items as possible on the first day of the availability.

3. Comparative Overview of Requirements

During fiscal year 1991, maintenance managers in the Mediterranean conducted over 38.4 million dollars worth of scheduled and emergent commercial maintenance. The scope of this effort included quick response emergent work and multiple (both planned and no-notice) maintenance availabilities on 160 surface ships of the Sixth Fleet and United States Naval Forces Central Command, spanning 30 different ports in 13 different countries. A total of 129 commercial availabilities (RAVs) and 61 Mediterranean and Red Sea tender IMAVs (four repair ships) were conducted during this period. An additional 188 USNAVCENT IMAVs were accomplished by six repair tenders independent of COMSERVFORSIXTHFLT. These scheduled maintenance availabilities greatly enhanced fleet operational readiness. [Ref. 11]

In comparison, during fiscal year 1990, maintenance managers in the Mediterranean conducted over 13.5 million dollars worth of scheduled and emergent maintenance encompassing over 60 different ships in 17 different ports and ten different countries. There were 60 commercial RAVs conducted and 62 IMAVs with three repair ships deployed to the Sixth Fleet. [Ref. 11]

The above comparison demonstrates the broad range of support that overseas maintenance managers must provide during times of regional crisis.

C. MAINTENANCE MANAGEMENT SUPPORT INITIATIVES

The scope of effort addressed in the preceding subsection of this chapter describes unique challenges in the planning and conduct of surface ship maintenance. Identification of new industrial bases, pre-positioning of selected support assets, and repair ship utilization are instrumental in sustaining high material readiness of the deployed fleet. These support initiatives are described in the following subsections. [Ref. 11]

1. Commercial Industrial Base Availability

An important aspect of ship maintenance policy overseas has been the identification and development of new or seldom used industrial bases (ports) to perform scheduled maintenance and emergent repairs. Industrial bases play a strategic role in support of contingency operations and can directly contribute to fleet operational readiness.

To support a continuous amphibious presence in the North Arabian Sea during operations Desert Shield and Desert Storm, a ship maintenance base was established in the United Arab Emirates. A temporary ship surveyor branch office (COMSERVFORSIXTHFLT SRU DET DUBAI) was opened in Dubai, United Arab Emirates, to manage surface ship maintenance

availabilities. The use of drydocks was significantly expanded enabling individual amphibious task force units to be rotated through the maintenance facility at Dubai for ten-day maintenance availability periods, starting every seven days. Operating from October 1990 until the facility closed in July 1991, the SRU detachment at Dubai managed 38 restricted availabilities (RAVs) during the nine month period - a benefit derived from a strategy of *forward basing.*

In April 1991, immediately following Operation Desert Storm, the presence of United States naval forces was required off the coast of Turkey to support ground troops providing assistance to the Kurds in Northern Iraq (Operation Provide Comfort). This operation tethered the Mediterranean Marine Amphibious Readiness Group (MARG) to Turkish ports in support of United States Marines ashore. The only available commercial maintenance facility capable of providing maintenance to deployed units in the Eastern Mediterranean was based at Haifa, Israel. As the situation stabilized in Northern Iraq, individual amphibious units were allowed to proceed (one at a time) to Haifa, Israel for scheduled maintenance. Meanwhile, alternative commercial ship repair sites were surveyed in Greece, Egypt, and Turkey.

A problem of how to maintain three warships assigned to the Maritime Interdiction Force emerged when the last aircraft carrier battle group departed the Red Sea in 1991.

The three ships had little onboard industrial capability and were mostly powered by single propulsion plants. Operational requirements also dictated that these units remain close to the North Red Sea. Local commercial contractor support was not available. A consensus maintenance plan was adopted between COMUSNAVCEN and COMSERVFORSIXTHFLT that exchanged Maritime Interdiction Force Units from the Red Sea to the Eastern Mediterranean to conduct planned maintenance.

Strategic positioning of mobile maintenance platforms (tenders) adjacent to fleet operations is essential for material readiness support. New tender safe havens (permission by host government to moor pierside or anchor in port and conduct maintenance operations) have been established in the following areas:

1. NATO pier at Souda Bay, Crete.
2. NATO pier at Agusta Bay, Italy.
3. Turkish Navy pier at Aksaz, Turkey.
4. Jebel Ali, United Arab Emirates.
5. Jeddah, Saudi Arabia.
6. Safaga, Egypt.
7. Hurgada, Egypt.

2. Surface Tender Utilization

Tenders stationed in the Arabian Gulf and North Arabian Sea (six repair ships) operated under specific task

force commanders. CASREP tasking was initially coordinated jointly between COMSERVFORSIXTHFLT and COMLOGSUPPFORSEVENTHFLT (Commander, Logistic Support Force Seventh Fleet). In February 1991, COMSERVFORSIXTHFLT SRU Detachment Bahrain assumed sole responsibility of coordinating the source of CASREP assistance. The deployed COMUSNAVCENT tender was the primary source of this assistance.

USS YELLOWSTONE (AD-41) was positioned at safe haven in Jeddah, Saudi Arabia, to provide longer IMAVs and coordinate Red Sea Repair efforts. In February 1991, USS PUDGET SOUND (AD-38) relieved USS YELLOWSTONE in Jeddah. During her subsequent westward transit of the Mediterranean Sea to CONUS, USS YELLOWSTONE provided much-needed radiac (radiological calibration equipment) support services to units in the Eastern Mediterranean and at Souda Bay, Crete (radiac equipment cannot be transported across foreign soil).

USS VULCAN (AR-5) was placed at safe haven in Hurgada, Egypt, in closer proximity to carrier battle groups and Maritime Interdiction Force units. From this position, the tender provided rapid, short-notice voyage repairs, Fly-Away-Teams, and easy access for Ship-to-Shop availability work. Upon departure of one Red Sea carrier battle group to the North Arabian Sea, USS VULCAN was repositioned to safe haven at Souda Bay, Crete, and supported afloat units on station in the Eastern Mediterranean.

As previously noted in subsection C.1. of this chapter, surface ships were periodically exchanged between the Mediterranean and Red Seas. This technique enhanced operational readiness by providing commercial restricted availability periods, tender intermediate maintenance availabilities, and enabled both Mediterranean and Red Sea units to be supported under a single maintenance plan.

3. Pre-positioning of Support Equipment

In 1990, as the tempo of naval operations increased in Southwest Asia, a strategy of pre-positioning was used to place contingency assets at remote locations to support emergent repairs. Gas turbine engines with generator changeout vans and spare engines were pre-positioned in Bahrain, Jeddah, Saudi Arabia, and Sigonella, Italy. This initiative ultimately resulted in on-station replacement of four gas turbine generators, five gas generators, and four power turbines. [Ref. 11]

In addition to establishing a forward base, equipment pre-staged at Bahrain included battle damage repair vans, water jet machines, lube oil flushing rigs, and emergency ship salvage materials. [Ref. 11]

D. MAINTENANCE RESOURCE MANAGEMENT SYSTEM

With COMNAVSURFLANT assistance, Maintenance Resource Management Systems (MRMS) were installed by NAVSEA at two sites in Naples, Italy, and at Bahrain. MRMS is a computerized system that is gradually being introduced to the fleet and is being installed at CONUS Readiness Support Groups (RSGs), Shore Intermediate Maintenance Facilities (SIMAs), Supervisors of Ship Building and Repair (SUPSHIPs), and tender repair ships.

1. System Background

MRMS is a computerized system that provides the Type Commander with an automated method of maintaining the force-wide CSMP. The system was developed to support the management of ship maintenance by enabling more effective management of maintenance assets and improving the response to maintenance deferrals originated by ships. Development of MRMS is consistent with long-term Ship's Non-tactical Automated Data Processing System (SNAP I,II), Type Commander's Headquarters Automated Information System (THAIS), and Intermediate Maintenance Management System-Real Time (IMMS RT). MRMS interfaces with other data processing systems which link the Navy's historical data files, shipboard maintenance projects, and both intermediate and depot-level repair facilities. The system serves as a CSMP holder ashore for automated ships and

maintains primary automated CSMP files for non-automated ships assigned to the system. [Ref. 13]

TYCOM maintenance personnel receive work requests from ships, update CSMP files, revise availability files, and screen job work items to repair activities within 96 hours from time of initial receipt of transmission from the fleet. MRMS is designed to provide the following basic services to system users [Ref. 14]:

1. Generate individual or bulk automated work requests (AWRs).

2. Produce CSMP 1B summary hard copy report or naval message tape.

3. Produce CSMP Report 2 (full narrative), CSMP Report 1C for the Board of Inspection and Survey (INSURV), and CSMP Report 1D (safety summary).

4. Transfer CSMP data via AUTODIN, modem, 9-track magnetic tapes, or floppy disk.

5. Load standard Maintenance Data System (MDS) data.

6. Produce Casualty Report (CASREP) summaries from daily inputs.

7. Produce Type Commander Work Package Tracking (TWPT) reports.

8. Update MDS files at Navy Maintenance Support Offices (NAMSO).

9. Produce complete package or multipart OPNAV 4790/2Q reports for each unit, as requested, immediately prior to INSURV inspection.

10. Load Master Job Catalog (MJC) work items to a specific CSMP for non-automated units.

11. Load standard MDS data from communication station produced tapes containing consolidated Ship Maintenance Action Form (SMAF) inputs.

12. Accept calldown message tapes and automatically transfer Job Sequence Numbers (JCNs) from CSMP to an availability file.

13. Load INSURV, Pre-Overhaul Test and Inspection (POT&I), and Repair Maintenance Management System Class Maintenance Plan (RMMS CMP) items to individual CSMP accounts via RMMS or naval message tapes for non-automated units.

14. Screen, review, and modify deferrals on line for non-automated ships.

15. Screen incoming data for critical data elements and errors, and produce error summary reports.

2. Overseas Adaptation

MRMS service needs by overseas maintenance managers are distinct from, and often combine several of, the basic system designed services. Several new and adapted programs are being written in 1992 with COMSERVFORSIXTHFLT assistance [Ref. 11]:

1. Financial Tracking Module - Provides a faster method in tracking maintenance funds to enhance financial accountability. Program design will track a job from ship surveyors original government estimate through contract award and any subsequent revisions to final close out or termination of the contract. Naval Regional Contracting Center Naples, Italy, is assisting in program development.

2. Work Specification Module - Provides work specification commonality throughout COMSERVFORSIXTHFLT SRUs to monitor the quality of foreign contractor repairs (an adaptation from the SUPSHIP function). The module is

now in operation at SRU Naples, Italy, and Bahrain.

3. Contractor Port Facility Module - Provides key data on Master Ship Repair Agreement (MSRA) contractors and on facilities in foreign ports where repairs are conducted.

4. Technical Representative Tracking Module - Provides an active data base to track all CONUS, MOTU-SIX, and tender technical personnel currently traveling in theater. The program will assist in diverting technical representatives to higher priority requirements.

5. Work Tracking Module - Provides near real time tracking of tender and SRU repair work (an adaptation from the RSG function). This module will also enable data exchange via Streamlined Alternative Logistics Transmissions (SALTS) to tenders and CONUS RSGs as required.

6. CASREP Tracking Module - Provides Type Desk officers a more responsive paperless CASREP tracking system which is integrated with the logistic (repair parts) CASREP tracking system (an adaptation from the prototype THAIS module). The key advantage is the ability to read CASREP messages from a computer disc directly into the data base.

7. Equipment Tracking Module - Provides maintenance managers the ability to track pre-positioned equipment at remote staging sites and on deployed tenders.

8. Scheduling Module - Provides automated timeliness to maintain currency with flexible schedules.

9. Technical Data Link - Provides connectivity with CONUS SUPSHIP and SIMA data bases, and the Planning and Estimating for Repair and Alteration (PERA) test document data base through the Department of Defense Network (DDN).

10. Historical Maintenance Availability Data Base - Provides historical data on foreign port usage and tender utilization.

E. STRATEGIC POLICY ISSUES

The lessons learned from recent conflict in the Middle East and Southwest Asia provides valuable insight for maintaining fleet readiness during times of regional crisis. The capability to sustain material readiness must now be maintained despite impending budget constraints.

This section addresses key strategic issues now confronting surface ship maintenance managers in the Mediterranean area of operations [Ref. 15].

1. Quality Maintenance Time

To remain at peak operational effectiveness, ships require quality maintenance time for both self maintenance and outside assistance. The current agreement between CINCUSNAVEUR and CINCLANTFLT provides 14 uninterrupted days of RAV or IMAV, 14 uninterrupted days of ship's force upkeep for the first quarter deployed, and 5 days each per month prorated throughout the remainder of deployment. These periods cannot run concurrently.

The value of ship's crew self maintenance and liberty can not be measured merely in dollars alone. These priorities must be balanced against adhering to planned maintenance committments as well as operational exercises.

2. Conduct Repairs in Theater

Experience from Operation Desert Shield and Operation Desert Storm has shown that it is rarely prudent to defer mission essential repairs to CONUS. Every deployed ship should be maintained fully mission capable by putting a minimum reliance on emergent repairs. The practice of deferring maintenance in CONUS prior to deployment further complicates the task of maintaining material readiness when maintenance deferred equipment fails in theater. For logistic considerations, all maintenance availabilities in theater should be accomplished at or near an airhead to minimize material shipment leadtime.

3. Mobile Maintenance Platforms

It is strategically important for the United States Navy to maintain surface tender capability in the Mediterranean theater of operations if activities in this area are likely to continue to pose a threat to United States and allied interests. Repair ships represent a flexible industrial base that provide mobile repair capacity and technical expertise which are crucial for maintaining naval forces in *any* forward deployed or potentially hostile environment.

In 1990, during Operation Sharp Edge, Fly-Away-Teams comprised of Mediterranean tender technicians were placed onboard amphibious ships remotely located in the Eastern

Atlantic Ocean off the coast of Africa. The technical capability provided by these teams greatly enhanced the repair capability by own ship's force.

Between 1990 and 1991, over 600 technical assist visits, many by multiple tender technical experts, were conducted in support of ship CASREPS in the Eastern Atlantic Ocean, North Arabian Sea, Mediterranean Sea, Red Sea, and Arabian Gulf [Ref. 11].

Foreign, shore-based commercial maintenance facilities and contractors are restricted primarily to major non-nuclear and unclassified (for reasons of technological security) Hull, Mechanical, and Electrical (HM&E) work packages. Nuclear, electronic, combat systems, and calibration capability is limited to assets organic to the United States Navy; deployed tenders are the most cost effective source asset for support.

4. Fiscal Accountability

As addressed in subsection B.1.a. of this chapter, the Mediterranean maintenance budget (approximately $50 million in FY 91) is supported from several different sources. Individual cost elements derived from a ship's repair work package such as material costs, labor manhour rates, utility costs, Ship Repair Unit and Naval Regional Contracting Center labor costs, or pierside support costs are not all funded from the same source. Ultimately, commands making decisions that impact upon maintenance costs are *not accountable* for the

funds they cause to be expended. Type commanders have direct control over repair funds and indirect control of the repair process [Ref. 16]. Operational schedules have traditionally commanded a higher priority over maintenance schedules and maintenance related costs (see Chapter IV, subsection C.3 of this thesis).

F. SUMMARY

This chapter has addressed surface ship maintenance and repair requirements in an overseas environment where, in 1992, the largest number of United States naval forces since the Second World War were employed. During a 15 month period, maintenance managers based in the Mediterranean theater provided maintenance on fully one-third of the Navy's surface ships. Maintenance initiatives taken by maintenance managers to support this mammoth task demonstrate the importance of timing, positioning, and flexibility.

Regardless of operational tempo, overseas maintenance managers have two basic industrial bases to draw from: shore based industrial facilities and mobile maintenance platforms. Each source has its advantages and disadvantages, but *both* are required if optimal material readiness is to be efficiently maintained for Navy ships.

The Maintenance Resource Management System promises to provide overseas maintenance managers a valuable tool in planning, tracking, and assessment of surface ship maintenance

actions, including fiscal accounting of resources expended.

Overseas maintenance managers are confronted with surface ship maintenance and repair problems that often are difficult to control. Examples include quality maintenance time and assuring accountability for maintenance costs incurred caused by operational decision-makers.

Finally, surface tenders are strategically crucial in maintaining a deployed naval force. Repair ships provide the overseas maintenance manager a *mobile* maintenance capability that shore-based maintenance activities cannot inherently provide. As Admiral Miller stated, "*We must learn to use our assets smarter. With a smaller fleet, there will be fewer units positioned forward. Those forces must be able to respond to crises in any theater.*" [Ref. 2]

The next chapter provides an evaluation of research findings on critical issues related to overseas resource requirements.

IV. EVALUATION OF RESEARCH FINDINGS ON SURFACE SHIP MAINTENANCE AND REPAIR REQUIREMENTS OVERSEAS

A. INTRODUCTION

The previous three chapters have addressed the need to assess material readiness issues and the effects of funding constraints on surface ship maintenance and requirements overseas, identified current innovative surface ship maintenance and repair issues, and provided an overview of surface ship maintenance requirements in maintaining material readiness of forward deployed naval forces. With this foundation, it is now possible to examine the underlying issues concerning overseas resource requirements.

An assessment of alternative source maintenance costs, the underlying issues confronting overseas maintenance and repair contracting, and the effects of current and projected funding constraints are presented.

Because of vast geographical distances to source locations, information for this analysis was gathered primarily through telephone interviews and substantiated with subsequent documentation received from each respective source. Interviews were conducted with both junior and senior government personnel including budgeting analysts, ship-type planners and requirements programmers, contracting officers in

ship repair, and maintenance managers responsible for provision of surface ship maintenance and repair overseas.

B. CURRENT TRENDS IN SURFACE SHIP MAINTENANCE

1. Mobile Maintenance Platforms

The Navy surface force has witnessed a dramatic reduction in repair ship assets within the past three years. A listing of commissioned surface repair ships available in 1989 and in 1992 are shown in Table 1 to illustrate this trend [Ref. 16].

TABLE 1: COMMISSIONED SURFACE REPAIR SHIPS

Surface Repair Ship 1989	Surface Repair Ship 1992
AD-15 USS PRAIRE	AD-18 USS SIERRA
AD-18 USS SIERRA	AD-19 USS YOSEMITE
AD-19 USS YOSEMITE	AD-37 USS SAMUAL GOMPERS
AD-37 USS SAMUAL GOMPERS	AD-38 USS PUDGET SOUND
AD-38 USS PUDGET SOUND	AD-41 USS YELLOWSTONE
AD-41 USS YELLOWSTONE	AD-42 USS ACADIA
AD-42 USS ACADIA	AD-43 USS CAPE COD
AD-43 USS CAPE COD	AD-44 USS SHENANDOAH
AD-44 USS SHENANDOAH	AR-8 USS JASON
AR-5 USS VULCAN	
AR-6 USS AJAX	
AR-7 USS HECTOR	
AR-8 USS JASON	

Within the next two years, it is possible that three additional repair vessels will be decommissioned leaving a balance of six surface repair ships available for employment by 1995. Of the six remaining vessels, three would be available to support operations in the Atlantic theater and three would be available to support operations in the Pacific theater. Table 2 illustrates surface repair ship availability based on the additional reduction of three ships [Ref. 16].

TABLE 2: SURFACE REPAIR SHIP AVAILABILITY

East Coast Surface Repair Ship	West Coast Surface Repair Ship
AD-38 USS PUDGET SOUND	AD-37 USS SAMUAL GOMPERS
AD-41 USS YELLOWSTONE	AD-42 USS ACADIA
AD-44 USS SHENANDOAH	AD-43 USS CAPE COD

Interviewees from both TYCOM offices (COMNAVSURFPAC and COMNAVSURFLANT) indicated concern over the age of the repair platforms. The repair platforms shown in Table 2 will range in age from 35 to 40 years by the year 2000.

There are no current plans to replace these platforms through new construction. A previous proposal for construction of the ARX (auxiliary repair platform) was

previously disapproved. Interviewees indicated that the proposed platform was controversial because it consolidated most auxiliary ship type requirements creating a universal or common ship which could support all ship types and major classes. Included in the configuration was a repair part load list and storage of large pre-fabricated plates for each major class of ship. As one interviewee stated, "It would of taken a platform the size of two aircraft carriers just to carry all that." The ARX also faced stiff competition in obtaining the required funding. New construction of surface ship combatants commands a much higher priority than auxiliary support ships. Based on the consensus of those interviewed, the ARX project is now a dead issue.

2. Surface Ship Maintenance and Repair Funding

Interviews with TYCOM planning offices reveled that scheduled RATA (restricted availability/technical availability) requirements in fiscal year 1992 were fully funded, but indicated that this trend may not continue past fiscal year 1993. Future shortfalls might require greater time periods between scheduled maintenance availabilities, deferring more depot level work to Shore Intermediate Maintenance Activities (SIMAs) and surface repair ships. In addition, surface repair ships could be required to conduct more of their own scheduled availability work.

The possible impact from these changes on surface ship maintenance and repair requirements overseas could be two-fold. First, as more work items are deferred, the size of a supported ship's work package increases with a corresponding increase in work load on either the deployed tender or shore-based ship repair facility. The practice of deferring repair work for budgetary reasons may also increase the frequency of emergent repairs. If the downward trend in surface repair ship availability continues past 1995, demand on overseas shore-based maintenance facilities to provide the necessary support will increase. This contingency brings into focus the second issue.

Section 7309(c), of Title 10, United States Code, prohibits ships homeported in the United States from being overhauled, repaired, or maintained overseas except for voyage repairs. Interviewees from Ship Repair Unit, Naples, Italy, and Naval Sea Systems Command Management Office, Western Pacific Area, Pearl harbor, Hawaii, indicated that interpretation of the law may also include all *scheduled* repairs of ships homeported in the United States, rendering the term *voyage repairs* synonymous with *emergent repairs*. Based on this interpretation, the need for employing surface repair tenders overseas could become crucial if material readiness of deployed forces is to be maintained in remote areas.

C. SHIP MAINTENANCE AND REPAIR CONTRACTING OVERSEAS

All commercial ship repair contracts in the Mediterranean theater are awarded and administered through the Ship Repair Division, Naval Regional Contracting Center, Naples, Italy. A Master Ship Repair and Alteration agreement is the basic contractual instrument used in the provision of commercial ship repair work.

1. Master Ship Repair and Alteration Contracts

The Master Ship Repair and Alteration (MSRA) contract is an agreement between the United States Government and a commercial contractor certified to perform ship repair work on Navy ships. The purpose of a MSRA is to establish, in advance, the terms and conditions under which the contractor will perform (Basic Ordering Agreement). The use of MSRA procedures expedites subsequent awards of Job Orders for actual repair work, reduces administrative efforts and costs, and provides contractors the opportunity to bid on and perform repair work under uniform and consistent terms and conditions. A MSRA is not a guarantee of work, an entitlement to future awards, or a certification of the contractor's ability to perform every repair job. In addition, a MSRA related Job Order cannot be utilized to purchase material or work that is not a part of the Ship Alteration and Repair Package (SARP). [Ref. 17]

A commercial contractor, wishing to obtain an MSRA contract, submits a request for award to Naval Regional Contracting Center Naples, Italy. The administrative contracting officer (ACO) determines whether to award or deny the request based on results of a pre-award survey conducted at the prospective contractor's facilities. Upon award, the MSRA is revised periodically to incorporate any changes in statutes or procurement regulations. To compensate for changes in international monetary markets, contract line item (CLIN) pricing is adjusted on all MSRAs prior to the beginning of each fiscal year and remains fixed throughout the 12 month period. An MSRA is not transferable. If a contractor's repair facility is sold or ownership changes, the agreement is cancelled. [Ref. 17]

2. Current Contracting Procedures

As noted previously in Chapter III, final preparations of depot level maintenance periods (RAVs) are accomplished immediately following arrival of the supported unit for repairs. Based on the proposed work package, funding requirements are estimated and justified by ship surveyors. These estimates ultimately serve as the government estimate to be used by the contracting officer in evaluating competitive bids from prospective contractors.

Contractors, possessing valid MSRAs, are invited on board the ship to ship-check the proposed work package. Each

contractor submits a formal bid to the cognizant contracting officer. The bids are evaluated and a firm-fixed-price job order is awarded to the successful contractor. The contractor orders any non-government furnished material (unless constrained by time length of availability) and commences contract performance. Interviewees at both Naval Regional Contracting Center and Ship Repair Unit at Naples, Italy, indicated that final contract preparations are extremely fast-paced. As a general rule, MSRA purchase orders are awarded and contract performance begins within 24 to 36 hours after arrival of the supported unit inport.

3. Contractual Issues and Problems

In November 1992, there were 38 MSRAs administered through Naval Regional Contracting Center, Naples, Italy. The Ship Repair Division is authorized one supervisor, four contract specialists and one clerk typist. Each contract specialist is limited in contractual authority (warrant) to $50 thousand. One contracts representative is required to be on-site or on-call at each port during contract performance. Based on organizational strength, a maximum of four different ports can be covered at one time. Based on an interview with the Supervisor of the Ship Repair Division, the current organization is large enough to support current demand of approximately 40 restricted availabilities per year. When demand increases, such as during Operation Desert Storm,

contracts personnel were "borrowed" from other divisions at the contracting center at Naples, Italy, to administer the additional requirements.

Interviewees at both Naval Regional Contracting Center and Ship Repair Unit, Naples, Italy, admitted the possibility of contractor buy-ins (the practice of a contractor submitting a bid known to be below their costs just to get the contract, with the intent of adding "full cost" work later) but indicated that any cost incurred, as a result of this practice, would be minimal. Costs incurred from growth work after contractor performance begins is limited due to time constraints of the maintenance availability. Additional work that cannot be conducted during the same maintenance availability period is deferred (ship mission permitting) to the next availability. The work is ultimately included in a new job order which is competitively awarded. This restricts the incentive for a contractor to buy-in and try to get-well later. In addition, the practice of buy-ins would be primarily limited to the Naples, Italy, region which encompasses seven of the 38 MSRA contractors. Repair ship competition at other regions in the Mediterranean is more limited, with some areas supported by sole-source contractors.

The Supervisor, Ship Repair Division, also indicated that a primary problem leading to higher repair costs stems from cultural differences between the various MSRA contractors

and the United States Navy. The standard Israeli work week starts on Sunday and ends on Thursday. The standard Islamic work week starts on Saturday and ends on Wednesday. As an example, if a Navy ship arrives at the shipyard at Haifa, Israel to conduct repairs on a Friday or Saturday, overtime must be paid. An added premium is required for holidays. As the interviewee noted, "The Navy is notorious for scheduling ships inport on a Friday to conduct repairs over the weekend, then back out to sea on Monday morning." This practice provides additional support to the issue that operational commanders make decisions that impact on maintenance costs, but are not held accountable for the additional costs incurred.

D. ASSESSMENT OF OVERSEAS SURFACE SHIP MAINTENANCE COSTS

1. Mobile Maintenance Platforms

Elements of surface tender maintenance costs fall into two categories: materials used to complete repair jobs and the inherent costs (fixed costs) of operating a mobile surface platform.

Ship repair tenders procure material with and manage the expenditure of Repair of Other Vessel (ROV) maintenance dollars. These mobile platforms also have the capacity to carry a storehouse of military specification (MIL-SPEC) materials for fabrication and high usage repair parts (Tender Load List) on board. Excluding the fixed costs of operating

a tender, maintenance repair jobs are essentially accomplished at a visible cost of material only, which is supported by Type Commander ROV funds.

As previously noted in Chapter III, the current agreement between CINCUSNAVEUR and CINCLANTFLT provides for 14 uninterrupted days for an IMAV overseas. Availabilities conducted in CONUS encompass 21 days for both tender and SIMA shore based IMAVs. A comparison in material expenditure and productivity between IMAVs conducted in CONUS and those performed by surface tenders deployed in the Mediterranean theater is shown in Table 3 [Ref.15].

TABLE 3: SURFACE SHIP IMAV MATERIAL COSTS

Source of Repairs	Length of IMAV Period	Costs[1] per IMAV Period	Jobs[2] per IMAV Period	Production Rates[3]	
				Jobs/Day	Cost/Job
Tender (Deployed)	14 days	$ 25k	325	23.2	$ 76.92
Tender (CONUS)	21 days	$ 35K	325	15.5	$107.69
SIMA (CONUS)	21 days	$ 110K	350	16.6	$314.28

[1]ROV material requirements for completed jobs
[2]Average number of work package items started and completed
[3]Average daily production rate and ROV material cost per job

The average surface tender material cost averages approximately $108 per job during a 21 day cumulative tending

day CONUS IMAV. The average SIMA material cost averages approximately $314 per job for a 21 cumulative tending day CONUS IMAV. The average material cost averages $77 per job for a deployed surface tender during a shorter 14 day availability period.

The lower cost and higher productivity rate experienced by deployed tenders is primarily attributed to the environment in which repairs are conducted. As previously addressed in Chapter III, ship checking the scheduled IMAV work package may not be feasible prior to arrival of the supported unit alongside the tender. Day one of the scheduled 14 day availability period starts immediately upon arrival of the supported unit. At the same time, tender repair personnel complete any remaining ship checks and verify actual equipment conditions. Growth work is assessed, material requirements are identified, and repair work commences on as many jobs as possible. Based on a 14 day availability constraint, procurement of non-available materials requires short lead-times. The 14 day time constraint ultimately minimizes overall material costs by restricting procurement to materials actually utilized in performance of maintenance and repair work during a respective maintenance availability period.

Productivity throughout the deployed maintenance availability remains high. Individual work items are signed off upon completion by the respective tender repair personnel

responsible. The sign off procedure documents accountability of work and provides the tended unit's commanding officer a certain measure of quality on repair work performed. Deployed tender personnel are highly trained, representing a captive and highly innovative work force. In a deployed environment, tender repair personnel thrive on self-sufficiency [Ref. 15].

The prevention of long lead-time procurement may cause some repairs, involving unique or complex material requirements, to be deferred. Procurement of unique materials also involves higher costs which, at times, include material requirements for support of higher and more complex (depot) level repairs. Repair item complexity is a contributing factor of higher material costs for CONUS based repairs as shown in Table 3. CONUS based IMAVs entail 21 vice 14 day availability periods and are geographically closer to material sources.

2. Shore Based Industrial Facilities

Elements of Ship Repair Unit (SRU) maintenance costs include government furnished material (GFM) and contractor furnished material (CFM), SRU and Naval Regional Contracting Center overhead expenses, contractor labor manhour rates, and shore service Mobile Utility Support Equipment (MUSE) support [Ref. 15].

a. Material Charges

Experience has shown that foreign commercial contractors will stock United States Military Specification (MIL-SPEC) material if deemed profitable by the contractor based on historical demand, and if the contract includes a provision requiring the Government to finance the purchase. Commercial contractors located in Naples, Italy and Haifa, Israel are currently contracted to carry a limited amount of United States MIL-SPEC material.

As previously noted in Chapter III, commercial contractors are restricted to major non-nuclear and unclassified Hull, Mechanical, and Electrical (HM&E) work. Foreign contractor furnished material is common to commercial ship type requirements. Supported Navy units generally provide most MIL-SPEC material and carry unique ship's system repair parts on board.

b. Labor Overhead Expense

Ship Repair Unit, Naples, Italy, was established with authorized staff positions to support an estimated 40 restricted availabilities (RAVs) per year. Salary and overtime expense of SRU surveyor, comptroller, and MUSE engineer personnel are paid for by CINCUSNAVEUR Operating Budget. Surveyor and MUSE engineer travel expenses are supported by CINCLANTFLT TYCOM RATA funds.

Civil service surveyors for conducting surface ship repairs are required on-site at respective foreign commercial facilities. For reasons of safety, contractual, and quality assurance considerations, surveyors remain on call during all hours of actual contractor performance. Within the first nine months of fiscal year 1992, SRU surveyors completed over 40 RAVs [Ref. 15]. Personnel expenses of NRCC Ship Repair Division includes salary, overtime, and travel, and are funded by Naval Supply Systems Command (NAVSUP). One contract specialist is required to be on-site and on-call during every major RAV.

c. Labor Manhour Rates

Average labor manhour rates of foreign commercial contractors located in the Mediterranean theater are shown in Table 4 [Ref. 15]. For purposes of comparison, labor manhour rates of CONUS based Tiger Teams and deployed surface tenders are also shown [Ref. 15]. Manhour rates are based on the assumption that maintenance manhours required to accomplish the same job are identical for all repair activities. This assumption is unrealistic, but creates a common standard for computation of normative rates.

TABLE 4: LABOR MANHOUR RATES

Source of Work Performance	Average Cost per Manhour
1. Bahrain	$ 11.34
2. Egypt	$ 12.00
3. Turkey	$ 14.00
4. United Arab Emirates	$ 14.50
5. Spain	$ 20.83
6. USN Tender	$ 22.60
7. Gibraltar	$ 23.10
8. Portugal	$ 23.10
9. Greece	$ 23.85
10. Israel	$ 28.86
11. France	$ 30.17
12. Italy, Naples	$ 32.99
13. Italy, All Other	$ 43.20
14. CONUS Tiger Team	$ 50.00

Dollar fluctuation in international monetary markets does not effect manhour costs directly. Manhour rates are budgeted and fixed at the beginning of each fiscal year, and represents the rate charged to respective CINCLANTFLT and CINCPACFLT RATA accounts.

The surface tender manhour rate is based on both production and overhead personnel of an average sized surface

tender repair department. The manhour rate includes base salary and benefits, and is based on a 40 hour work week. Tender repair department personnel routinely work in excess of a 40 hour week without overtime or other premium time considerations.

The CONUS Tiger Team manhour rate is based on normative shipyard manday rates and overhead, but does not include required PERDIEM or transportation costs. These expenses, in conjunction with a high manhour rate, are indicative of the high costs incurred when Fly-Away-Teams are deployed from CONUS.

d. Mobile Utility Support Equipment

Ship Repair Unit, Naples, Italy, maintains a fleet of Mobile Utility Support Equipment (MUSE) capable of providing certified steam and regulated electrical power to supported units. MUSE capability enables ships to go *cold iron* for conducting engineering plant repairs inport. In fiscal year 1991, COMSERVFORSIXTHFLT expended $9.8 million on a combination of government owned MUSE, long-term lease MUSE (Bahrain), and commercial MUSE Spot Purchases [Ref. 15].

MUSE shore services also can be used to conserve fuel. A steam ship inport operating the engineering plant under *auxiliary steaming* or *modified main* uses substantially more fuel than shore MUSE support. Based on notational burn rates, gas turbines and diesel ships also use more fuel inport

than shore based MUSE support. Surface tenders can provide steam and electrical support but are limited to the number of ships that can be supported at one time.

Commercial spot purchase MUSE uses commercial fuel to avoid damage claims against the Government by the contractor based on contaminated fuel. Commercial fuel is funded by CINCLANTFLT allotment and is substantially more expensive than Navy tax-free fuel. Based on current usage, the nominal cost differential for use of commercial fuel ($4-5/gal) vice Navy tax-free fuel ($0.68/gal) equates to approximately $18,000 per day. Government owned MUSE use tax-free fuel. [Ref. 15]

MUSE transportation and related travel charges vary by port location and are fixed at the beginning of each fiscal year. These costs do not apply to spot purchase MUSE. Because of contractor buy-ins, trip costs are higher at ports most frequented by Navy ships. [Ref. 15]

3. Eliminating Repair Ship Capability

Overseas maintenance managers have two basic industrial bases to draw from: shore based industrial bases and mobile maintenance platforms. As previously addressed in subsection B.1. of this chapter, the number of commissioned repair ships continues to decrease and the extent to which this trend will continue remains unknown. Based on the premise that repair ships are eliminated, this subsection

assesses the impact on surface ship maintenance and repair operations in the Mediterranean theater.

a. Restricted Availability Requirements

Conducting RAVs at shore based facilities on all deployed surface ships at the current fiscal year 1992 level and utilizing alternative Fly-Away-Teams (FATs) could potentially increase CINCLANTFLT and CINCPACFLT RATA funding requirements from the current $30 million to approximately $90 million annually.

The average deployed surface tender completes between 1000 and 1200 repair jobs every two weeks [Ref. 15]. Based on an average completion rate of 325 jobs per supported unit (TABLE 4), surface tenders currently provide an equivalent of 3.4 IMAVs every two weeks or approximately 88 maintenance availabilities per year.

Current annual RATA expenditures to support 40 RAVs is approximately $25 million [Ref. 15]. An additional 88 RAVs, representing a requirement increase of 220%, creates a potential net increase of approximately $55 million in annual RATA funding requirements.

The average surface tender also corrects over 300 surface ship CASREPS per deployment and fields over 100 FATSs [Ref. 15]. Elimination of surface tender capability would result in the combined use of CONUS technicians, Naval Shipyard Tiger Teams and possible deferral of repairs to

foreign commercial technicians. The alternative use of these sources is estimated to require an additional funding increase between $2 million and $4 million annually, depending upon CASREP frequency and severity.

b. Ship Repair Unit Structure

In addition to RATA expenditures, a 220% increase in RAVs could potentially create a substantial increase in the current $2 million CINCUSNAVEUR Operating Budget [Ref. 15]. COMSERVFORSIXTHFLT Ship Repair Unit located in Naples, Italy, would require relocation to facilitate increased space requirements. The added demand in RAV and CASREP assistance would create a corresponding increase in ship's surveyor, HM&E technician, combat system technician, and administrative personnel requirements. The requirement for NRCC ship repair contract administrators is estimated to increase from four to ten contract specialists. Under the current SRU organizational structure, the majority of additional personnel requirements would be staffed with civil servants, creating proportionate increases in overtime, PERDIEM, and travel expenses.

The CINCLANTFLT open ended MUSE allotment would also increase from the current $10 million expenditure level. To support an additional 88 RAVs, an increase in contractor MUSE would be required pending procurement of new Government owned MUSE units.

c. Additional Considerations

Surface ship tenders provide the overseas maintenance manager a flexible and mobile maintenance capability to support deployed units in remote geographic locations. Shore based maintenance facilities cannot inherently provide this capability. Dependence on technical expertise and material from CONUS, or contracting from foreign sources, will cause critical delays in responding to ship CASREPS.

Without a mobile warehouse of stocked materials and repair parts to draw from (Tender Load List), additional delays will be incurred acquiring critical materials. This also may require additional expenditures for procurement and pre-positioning of repair equipment material at remote locations.

The provision of logistical flight support in the Mediterranean theater is a joint responsibility, shared between Air Force and Naval Air components. Logistic connectivity and dependability of flight services between remote geographical locations will be crucial for transport of both material and technical personnel.

E. ALTERNATIVE RESOURCE REQUIREMENT CONCEPTS

Section B of this chapter addressed current funding trends and resource requirement trends confronting surface ship maintenance managers overseas. This section addresses two

alternative concepts for providing mobile ship repair capability overseas.

1. Mobile Ship Repair Facilities

Commander in Chief, United States Pacific Fleet, is developing a prototype Mobile Repair Ship Facility (MSRF) capable of providing a full range of intermediate maintenance level repairs as well as capabilities for various depot level repairs [Ref. 18].

The MSRF will utilize assets taken from Ship Repair Facility, Subic Bay, Philippines, and will be comprised of a self-docking floating dry dock with 17,200 tons lifting capacity, repair barges, berthing barge, power barge with floating crane, and pusher boats. The facility, which can be deployed with or without the dry dock, will be manned by nine military personnel, six senior supervisory civil service personnel, and a crew of approximately 350 foreign contractor personnel. When required, intermediate or depot maintenance level Tiger Teams could also augment the MSRF work force. [Ref. 18]

An estimated 12 months will be required to develop the MSRF project. As of November 1992, interviewees at CINCPACFLT indicated that the MSRF project had still not been funded. Also, the requirement to contract a crew by a foreign contractor may be prohibited under Section(c) of Title 10, United States Code.

2. Universal Repair Ship Concepts

The universal repair ship concept is based on combining the capabilities of a surface repair tender and a submarine repair tender. The concept is not new, and has been successful in the past.

In January 1991, USS MCKEE (AS 41), homeported in San Diego, California, deployed to the Persian Gulf in support of Operation Dessert Shield and Operation Desert Storm. Pre-deployment preparations required a revised Tender Load List (6000 additional line items), technical documentation, and repair equipment required to support surface ship classes. Within the first 30 days after arriving on station in the Persian Gulf, USS MCKEE completed 13 technical availabilities and over 1,300 individual surface ship repair jobs. Based on the success of MCKEE, the universal concept has proven to be a viable alternative under demanding conditions. [Ref. 19]

F. SUMMARY

1. Trends in Surface Ship Maintenance Requirements

The number of surface repair ships available for employment will continue to decrease. It is highly probable that only six surface ship tenders will remain in service by 1995, and it is possible that there will be fewer than this number. There is no plan, nor are the resources available, to replace the aging fleet of surface ship tenders through new construction.

The overseas maintenance manager has two basic ship maintenance repair sources to draw from: shore-based commercial facilities and deployed repair ships. Based n current trends, continued employment of repair ships overseas may be in jeopardy. Pursuant to Section 7309(c), of Title 10, United States Code, repairs at overseas commercial facilities may be restricted to emergent mission essential repairs only. The overseas maintenance manager will ultimately have no other alternative to draw from, and material readiness of the deployed fleet could suffer as a result.

2. Ship Maintenance and Repair Contracting Overseas

The Master Ship Repair and Alteration agreement (MSRA) is the basic contractual tool used in providing commercial ship repair and maintenance overseas. An MSRA does not include a guarantee of work. Based on the MSRA, actual contract work is competitively awarded through individual job orders.

The possibility of contractor buy-ins does exist, particularity in the competitive market surrounding Naples, Italy, but was not considered by the interviewees to represent a significant problem. Because of timing constraints, work package growth during a specific maintenance availability is limited. Work deferred to another availability is competitively awarded under new job orders.

A primary cause of unexpected increases in maintenance and repair costs is the practice of scheduling ships inport for repairs during weekends or holidays. The problem applies to all ports and respective MSRA contractors located throughout the Mediterranean region, but is more acute in ports where the customary work week and religious holidays differ from American custom. As noted, operational commanders traditionally schedule deployed units for port calls on weekends, increasing overtime and other premium costs, but are not held accountable for these incremental costs.

3. Overseas Surface Ship Repair Costs

Deployed surface ship tenders incur lower material costs and provide support at higher productivity rates than other tenders and Shore Intermediate Maintenance Activities based in CONUS. A job item sign-off procedure documents repair accountability and provides the supported unit commanding officer a certain measure of quality on repair work performed.

Average labor man-hour rates vary considerably between regional MSRA contractor locations in the Mediterranean theater. The average man-hour rate for CONUS Tiger Teams represents the highest rate, excluding PERDIEM and transportation costs to and from CONUS. In the absence of any repair ship capability, annual RATA funding requirements could

potentially increase by 200 percent, based on fiscal year 1992 requirement levels.

Surface ship tenders provide a flexible and mobile maintenance capability to support deployed units in remote operational areas. Surface ship maintenance and repair facilities based on shore cannot provide this capability.

4. Alternative Resource Concepts

The long-term Naval presence in the Persian Gulf, coupled with the current Navy-wide repair ship shortage and loss of the Ship Repair Facility in Subic Bay, requires an alternative ship repair facility. The Mobile Ship Repair Facility concept encompasses Navy owned assets which are currently not being utilized, but could be used to provide a range of intermediate and depot level maintenance support in remote areas.

The universal repair ship concept provides a common repair ship platform to support both surface and submarine class ships. The concept is not new and proved to be an effective alternative for ships deployed in the Persian Gulf.

The final chapter answers the research questions outlined in Chapter I and offers some potential areas for further research.

V. CONCLUSION

A. REVIEW OF RESEARCH QUESTIONS

1. Research Question 1

What are the critical requirements and funding issues confronting maintenance resource facilities overseas?

The answer to the first research question regarding critical overseas requirements and funding was assessed in Chapters III and IV. The most critical issue confronting surface ship maintenance and repair capability overseas is the continued reduction and potential elimination of mobile repair platforms (tenders).

The decline in surface repair ship availability cannot continue at the current rate without severely effecting the high level material readiness requirement of a forward deployed fleet. Forward presence and crisis response are fundamental to a national military strategy that is regionally orientated [Ref. 10]. Surface ship maintenance and repair operations, conducted in support of Operation Desert Shield and Operation Desert Storm, provide clear evidence that mobile maintenance platforms are required to support deployed units in *remote* geographical locations during periods of regional crisis. Shore-based ship repair facilities, whether civilian or military, *cannot* inherently provide this capability.

The second most critical issue is the constraints placed on overseas shore-based maintenance and repair facilities. First, foreign commercial contractors are restricted primarily to non-nuclear and unclassified Hull, Mechanical, and Electrical (HM&E) repair work. Second, Section 7309(c) of Title 10, United States Code, prohibits ships homeported in the United States from being overhauled, repaired, or maintained overseas except for voyage repairs. Overseas shore-based maintenance capability is constrained not only as to the *type* of repair (HM&E) but, to the *timing* of the repair (scheduled vice unscheduled) as well. The timing constraint is externally imposed without regard to actual material condition.

2. Research Question 2

What effect will new Navy maintenance strategies have on planned requirements assigned to maintenance facilities overseas?

The Phased Maintenance Concept, Progressive Maintenance Concept, and Engineered Operating Cycle Programs were developed to support major class maintenance plans. There is no evidence to indicate that these initiatives will have any effect on ship maintenance and repair facilities overseas.

3. Research Question 3

Can Maintenance Requirement System (MRS) principles be applied during periods of deployment to improve material combat readiness?

The successful application of Maintenance Requirement System principles in the fleet will depend on the developmental progress of three separate programs: Assessment of Equipment Condition, Measures of Effectiveness, and Maintenance Requirements System.

The process of defining maintenance requirements is the foundation upon which the Maintenance Requirement System is based. Maintenance requirements are defined by the availability planning process. The Assessment of Equipment Condition program integrates condition based requirements in the work definition process. Data from the work definition process is then used to update the availability planning process. The Measures of Effectiveness program provides the tool for assessing the progress of both the Assessment of Equipment Condition and Maintenance Requirement System programs [Ref. 19].

If successful, these programs should provide shipboard personnel with the necessary diagnostic tools and techniques that will enhance condition based decision-making, resulting in a more cost effective management of risk.

4. Research Question 4

How can the concept of conditional based maintenance be reinforced through the use of mobile maintenance platforms such as tender repair ships?

Statistical evidence, based on CASREP studies, indicates that the more a ship steams and the longer it stays out of port, the greater the probability for a systems failure. On the other hand, higher levels of manning and a lower percentage of crew turnover improves a ship's material condition. In addition, the longer a commanding officer has had command of a ship, the fewer new CASREPS it will have. [Ref. 20]

This evidence supports the concept of condition based maintenance and the associated management of risk by the decision-maker. Because of lower turnover rates, trained and experienced ship crews are retained on board who are more knowledgeable with ship systems and actual material conditions. The decision-maker (commanding officer) is better able to manage risk because of a higher level of confidence in crew self-sufficiency. Surface ship tenders can be utilized to enhance this self-sufficiency by providing higher level technical training, and by involving ship crews (joint effort) in the conduct of scheduled or emergent ship repairs.

5. Other Observations

This thesis has identified critical requirement concepts and funding issues for maintaining material readiness of deployed forces. Of all the evidence gathered in conducting research for this thesis, the most serious observations relate to two critical issues concerning surface ship maintenance and repair capability. As identified in Chapter III and discussed in Chapter IV, the overseas maintenance manager has two basic ship maintenance activity sources to provide support in theater: shore-based commercial facilities and deployed repair ships. The number of surface repair ships available for employment overseas continues to decrease, while foreign shore-based commercial facilities are continually more constrained to voyage repairs. The overwhelming consensus, based on interviews conducted during research, is that the severity of this problem will continue or increase.

Navy repair ships are, and will continue to be, a scarce resource. Surface tenders have proven to be strategically crucial in maintaining a deployed naval force during times of regional crisis. Homeporting a surface tender overseas places the scarce resource where it can be utilized most effectively, maintaining material readiness of a deployed fleet.

As discussed in Chapter IV, congressional legislation under Section 7309(c), of Title 10, United States Code, places a larger dependency on deployed surface ships to provide maintenance support other than voyage repairs. With the absence of CONUS based surface tenders, demand at CONUS Shore Intermediate Maintenance Activities should increase. In effect, this could create common ground for a compromise between proponents of the Title 10, United States Code, and the Navy over the requirement to maintain material readiness of a deployed fleet. If successful, such agreement could also serve as the initial justification base for eventual replacement of an aging repair ship fleet which is the longer-term solution.

Finally, the Maintenance Repair Ship Facility concept, addressed in Chapter IV, provides evidence that the Navy owns ship maintenance resources that are not effectively utilized. If a surface repair ship were homeported overseas with assets such as floating cranes and floating drydocks, the Navy could acquire the inherent capability to conduct higher industrial level repairs thus reducing the dependency on foreign commercial contract requirements.

B. AREAS FOR FURTHER RESEARCH

The following areas are suggested for further research:

1. The feasibility for permanent deployment of surface repair ships (tenders) overseas. What would be the principal problems associated with homeporting all

available surface repair platforms overseas? What would be the impact on Shore Intermediate Maintenance Activities (SIMAs) in CONUS? What additional resources would be required to support depot level maintenance repairs and are these resources currently available in Navy owned inventory? (Feasibility Assessment)

2. The Universal Repair Ship. What is the feasibility of consolidating available surface and sub-surface auxiliary repair ship assets (AD & AS) into a common repair ship platform? What basic changes in the ships configuration, loading, and manpower requirements would be required? How could a universal platform be employed to support both surface and sub-surface units? What effects would a universal repair ship have on material readiness of a deployed fleet? (Feasibility Assessment)

3. Maintenance Requirements System. Can Intermediate Maintenance Activity (IMA) level maintenance data be linked to the Maintenance Requirements System (MRS) data development process? How can MRS be integrated at shore and afloat IMA facilities? What would be the hardware configuration requirements and feasibility for standardization? (Technical Feasibility Study)

APPENDIX A: LIST OF ACRONYMS AND TERMS

ACO	Administrative Contracting Officer
AEC	Assessment of Equipment Condition
CASREP	Casualty Report
CFM	Contractor Furnished Material
CLIN	Contract Line Item Number
CMP	Class Maintenance Plan
CNO	Chief Naval Operations
CONUS	Continental United States
EOC	Engineered Operating Cycle
FAT	Fly-Away-Team
GFM	Government Furnished Material
HM&E	Hull, Mechanical, and Electrical
IMAV	Intermediate Maintenance Availability
MARG	Marine Amphibious Readiness Group
MDS	Maintenance Data System
MIL-SPEC	Military Specification
MOE	Measures of Effectiveness
MOTU	Mobile Technical Unit
MRMS	Maintenance Resource Management System
MRS	Maintenance Requirement System
MSRA	Master Ship Repair Agreement
MSRF	Mobile Ship Repair Facility
MUSE	Mobile Utility Support Equipment

MWP	Mediterranean Work Package
NAVSSES	Naval Ship Systems Engineering Station
NRCC	Naval Regional Contracting Center
OPTAR	Operating Budget
O&S	Operating and Support
PERA	Planning and Engineering or Repairs and Alterations
PMA	Phased Maintenance Availability
PMP	Phased Maintenance Program
PMS	Preventive Maintenance System
PMT	Performance Monitoring Team
PROG	Progressive Maintenance Concept
RATA	Restricted Availability - Technical Availability
RAV	Restricted Availability
ROV	Repair of Other Vessel
SARP	Ship Alteration and Repair Package
SIMA	Shore Intermediate Maintenance Activity
SMART	Ship Machinery analysis and Research Technique
SRA	Selected Restricted Availability
SRF	Ship Repair Facility
SRU	Ship Repair Unit
SWLIN	Ship Work Line Item Number
SWAB	Ship Work Authorization Boundary
TLL	Tender Load List
TYCOM	Type Commander
VAMOSC	Visibility and Management of Operating and Support Costs

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